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ABSTRACT

A followup study of 151 lower socioeconomic class children (under 6 years of age at the time of initial screening) was conducted to determine the effectiveness of the Denver Developmental Screening Test (DDST) in predicting school achievement problems. Ss were originally categorized into three age groups (0-2 years, 2-4 years, and 4-6 years) and three DDST classifications (normal, questionable, and abnormal). Followup evaluation (which took place when Ss' school placement ranged from beginning kindergarten to grade 5) included the following: achievement test percentiles, grade placement or special education status, and teacher ratings on the School Behavior Check List. Based on the above data, Ss were classified as having school problems if they met one or more of four criteria (which included achievement test percentiles of ten or less). Results indicated that the majority of Ss categorized as non-normal had later school problems and that prediction became more accurate with increasing age of screening in abnormals. (SB)

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Infant and Preschool Developmental Screening and Later School Performance[1]

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The purpose of screening an asymptomatic population for a chronic disease or handicap is to move up the time of diagnosis and treatment to an earlier stage of the disease process. For many handicapping conditions early treatment results in less morbidity than treatment begun after the usual time of diagnosis.

If early positive screening findings are not predictive of later problems or morbidity, there is little value for that type of screening. Some people believe that early developmental screening findings should not be taken seriously since the child will outgrow such delays.

Concurrent validity studies of the Denver Developmental Screening Test (DDST) indicated a high correlation between Abnormal, i.e., significantly delayed performance, and intelligence test performance (Frankenburg, Goldstein and Camp, 1971).

To our knowledge there are no long term prediction studies of developmental screening tests. The one previous study of the DDST showed that non-normal scores among four-to six-year-olds did predict third grade school achievement problems (Camp, et al., 1974), but this prediction span was only three years.

There have been no data on the predictive accuracy of the DDST given below four years of age and reevaluated at school age. This paper presents a study of children screened with the DDST between three months and six years and reevaluated after a time span of five to six years. Two study questions were addressed.

1. What is the relationship between the DDST and school status five to six years later?

2. Is the accuracy of prediction from DDST scores affected by the age of the child at screening?

Method

Subjects. In 1969 and 1970, approximately 3,000 children from lower socioeconomic families were screened in the Denver Neighborhood Health Clinics for disorders in development, speech, vision and hearing. All children with borderline disorders (referred to here as "Questionable") and significant disorders (referred to here as "Abnormal") were referred to their physicians for diagnostic evaluations.

In early 1975, the complete DDST records of 2,715 children, screened between 1969 and 1970, were categorized by three age groups and three DDST classifications: Abnormal, Questionable and Normal. We randomly selected the records of 40 children from each of the nine age by classification cells. Three cells had less than 40. The total available Abnormals were limited to 29 and 31 at 0-24 and 24-48 months, respectively. The total available Questionables were limited to 36 at age group 24-48 months. A total of 336 records were selected. We were able to complete follow-up on 45 percent (151 of 336) of the children whose records were selected. Ninety-eight could not be located. Fifteen were known to have moved away from metropolitan Denver. Twenty records proved to be siblings of study children or different records for the same child. Four children had died. Twenty-two families refused to participate in follow-up. Twenty-six gave only partial follow-up cooperation, leaving their data incomplete.

Among the 151 completed follow-up children, there were between eight and 28 in each of the nine cells (see Table 1). The lower than

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Insert Table 1 about here

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expected rate of follow-up for Abnormals and the higher rate for Questionables resulted in a significant difference from the 45 percent expected rate for each cell (Chi-square = 10.94, df = 4, $p < .05$). Because of the large number of unlocated children, the follow-up biases cannot be explained.

Follow-up evaluation included the following. From the school, we obtained achievement test percentiles, grade placement or special education status, and a teacher-rated School Behavior Check List (SBCL). The SBCL (Miller, 1972) is a 96-item behavior scale standardized on a large population of urban children of varying social classes. At our office, we administered the Stanford-Binet Intelligence Scale.

Four criteria were used to classify children as having school problems: 1) achievement test percentiles of ten or less, 2) repetition of a grade or special education placement by administration action, 3) behavior problems sufficiently intense to be in the most deviant three percent on national norms on any of six SBCL subscales, and 4) current IQ less than 80. Children meeting any one or more of these four criteria were classified as having school problems.

Results

The DDST classifications of Abnormal, Questionable and Normal were significantly correlated with each of the four criteria of school failure. Chi-square values were significant at $p < .05$ or better. For example, the average of school achievement test percentiles was 22.9 for the Abnormals, 31.6 for the Questionables and 40.4 for

the Normals. Further, children who scored Abnormal on the DDST had a mean of 2.2 school problem criteria, Questionables 1.1 and Normals 0.7.

Having demonstrated the separate correlations, we then proceeded to the most practical relationship, which was the DDST scores vs. school problems of whatever type or number. Table 2 shows that 31

Insert Table 2 about here

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of 35 or 89 percent of children with Abnormal DDST classifications prior to school had significant school problems five to six years later. Sixty-three percent of Questionables or mildly deviant preschoolers had later problems. Thirty-eight percent of Normals had later school problems. The high base rate of school problems among children who looked normal prior to school needs comment, which will be given in the discussion below.

First consider the predictive accuracy of the DDST as a function of age at original screening. Table 3 shows the follow-up status of

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Insert Table 3 about here

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children screened below two years of age. At follow-up these children varied from end-of-year prekindergarten to end-of-year second grade. Seventy percent of Abnormals, 62 percent of Questionables and 22 percent of Normals had later school problems.

Table 4 shows the follow-up data on children screened between ages

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Insert Table 4 about here

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two and four years. At follow-up, these children varied from end-of-first grade to end-of-fourth grade. All eight of the Abnormals, 62 percent of Questionables and 50 percent of Normals had later school problems.

Table 5 shows the follow-up figures for the children screened at

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Insert Table 5 about here

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ages four to six. At follow-up these children varied from end-of-third grade to end-of-sixth grade. Ninety-four percent of Abnormals, 64 percent of Questionables and 41 percent of Normals had later problems.

The present results on this oldest age group at screening represents a cross-validation of the results from the previous study (Camp, et al., 1974). In that study, 15 of 17 (88 percent) of Abnormals, 14 of 23 (61 percent) of Questionables, and 8 of 25 (32 percent) of Normals had later school problems defined by the same criteria. Further, the Camp, et al., study children were an independent sample from the same population used here.

The age trends of predictive accuracy for the present study are summarized in Table 6. The span of prediction remains constant at

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Insert Table 6 about here

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five to six years. Prediction of school problems for children with Abnormal scores was 70 percent below two years of age to over 90 percent after two years of age. Questionables stayed at a constant 60 percent or so for each age group. Normals had an increasingly greater rate of school problems as the age of screening increased -- from 22 percent to over 40 percent after age two years.

Discussion

When considering the long term validity of a screening test, one must consider correct predictions as well as the errors. It is noteworthy that 89 percent of children with Abnormal screening results suffered school problems five to six years later (Table 2). But there were 4 of 35 or 11 percent Abnormals who had no problems later. It is interesting that three of the four "overreferrals" in Table 2 were infants when originally screened. Thus, at follow-up they were below third grade. Further, only 22 percent of the infant Normals (Table 3) developed school problems compared to higher percentages for Normals screened at older ages. It has been demonstrated elsewhere (Coleman, 1966) that school problems become more prevalent after third grade, presumably because of increasing demands on the child's general competencies in self-control and abstract skills. Thus, it may be that some of our younger study children may develop school problems in two or three years. This expectation applies to each DDST category.

Some overreferrals may have been Abnormals or Questionables who developed into the normal range following treatment for their developmental handicaps prior to school age. We have no systematic data on preschool interventions. To the extent than any intervention was beneficial, the true overreferral rate must necessarily be smaller than our study sample showed.

Follow-up of children with Questionable DDST results showed the expected intermediate level of school achievement percentiles and number of school problem criteria. Sixty-three percent of these

children developed one or more school problems (Table 2). Borderline results, even when taken during infancy, warrant follow-up screening. Failure to move into the normal range on rescreening would indicate referral for more comprehensive evaluation of developmental delays.

The study children with Normal DDST findings had the fewest number of school problem criteria. Nevertheless, 38 percent of Normals had problems. This figure is large but not unexpected. Our study group was mainly lower social class in terms of education and occupation level. The prevalence of major school problems in a whole population of predominantly lower class Kauai children was one third (Werner, et al., 1971). Werner also showed that cognitive deficit in children with low educational stimulation in their homes tends to increase with age. It seems likely, therefore, that some of the children with school problems could have been identified with non-normal DDST findings at the second or third screening prior to school age. This expectation is supported by larger percentage of two- to four-year-old Normals vs. four- to six-year-old Normals who had later school problems. Consistent with this trend for the older age groups is the finding of the previous study (Camp, et al., 1974) that a relatively low number (8 of 25 or 32 percent) of four- to six-year DDST Normals had school problems by third grade. Thus, the cumulative deficit hypothesis would predict that some of the two- to four-year-old Normals became Questionables by age six. Similarly, some of the four- to six-year Normals became school problems later. We cannot look at this study's figures (Table 3) for the youngest group in the light of cumulative deficit because these children had much less opportunity to develop school problems for reasons other than low IQ (<80).

Summary

1. The majority of low social class study children with non-normal DDST findings had later school problems. However, about 37 percent of Questionables had no school problems. Thus, it seems reasonable to confirm Questionable screening results within six months before referring for full evaluation. We also recommend that Normals be rescreened two or three times prior to school age. With increasing age, the likelihood increases that detracting environmental influences will manifest themselves in delayed performance.

2. Prediction became more accurate with increasing age of screening among Abnormals. The rise was from 70 percent accuracy to over 90 percent after age two years. The increase was interpreted to be the increased chances of older study children to have school problems because of their higher grade levels at follow-up.

These results are thought to be representative of lower class populations only. Available literature (cf., Willerman, et al., 1970) indicates that percentages would change significantly for mildly delayed children from middle class families.

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Footnotes

[1]Paper presented at the Society for Pediatric Research, St. Louis, Missouri, April, 1976. We greatly appreciate the support and cooperation of the Denver Public Schools in this project.

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Table 1

Study Protocol

1969-70: 2715 Screened 6 Months - 6 Years

1976 Follow-up

DDST	< 24 Months	24-48 Months	48-72 Months	Total
Abnormal	10	10	20	40
Questionable	15	23	31	69
Normal	20	19	21	60
Totals	45	52	72	169

Table 2

DDST vs. Follow-up

DDST Classification	Follow-up Status		Total
	School Problems	Normal	
Abnormal	31 (89%)	4 (11%)	35
Questionable	41 (63%)	24 (37%)	65
Normal	19 (38%)	32 (62%)	51
Total	91	60	151

Table 3

DDST vs. Follow-up
Below 24 Months

DDST Classification	Follow-up Status		Total
	School Problems	Normal	
Abnormal	7 (70%)	3 (30%)	10
Questionable	10 (62%)	6 (38%)	16
Normal	4 (22%)	14 (78%)	18
Total	21	23	44

Table 4

DDST vs. Follow-up
24 - 47 Months

DDST Classification	Follow-up Status		Total
	School Problems	Normal	
Abnormal	8 (100%)	0 (0%)	8
Questionable	13 (62%)	8 (38%)	21
Normal	8 (50%)	8 (50%)	16
Total	29	16	45

Table 5

DDST vs. Follow-up
48 - 72 Months

DDST Classification	Follow-up Status		Total
	School Problems	Normal	
Abnormal	16 (94%)	1 (6%)	17
Questionable	18 (64%)	10 (36%)	28
Normal	7 (41%)	10 (59%)	17
Total	41	21	62

Table 6

Percent of Children with School Problems According to Their DDST Classification and Age of Screening

DDST Classification	Age of Screening		
	0-2	2-4	4-6
Abnormal	70	100	94
Questionable	62	62	64
Normal	22	50	41